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A new species of iguanid lizard (Hoplocercinae, *Enyalioides*) from southern Ecuador with a key to eastern Ecuadorian *Enyalioides*

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Abstract

We describe a new species of *Enyalioides* from mid-elevation rainforests in southeastern Ecuador. This represents the fifth species of *Enyalioides* known to occur east of the Andes in South America; the other four species are *E. cofanorum, E. laticeps, E. microlepis* and *E. praestabilis*. Among other characters, the new species can be distinguished from other *Enyalioides* by having distinct caudal whorls, fewer than 32 longitudinal rows of dorsals at midbody, and bright orange to red gular scales bordered with black in adult males. Morphological similarity suggests that the new species, which we call *E. rubrigularis*, is closely related to *E. praestabilis*.

Keywords

Ecuador, *Enyalioides*, Hoplocercinae, Iguania, lizard, new species

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Introduction

The neotropical iguanian lizard clade Hoplocercinae (Torres-Carvajal and de Queiroz 2009) includes 12 species assigned to three taxa traditionally ranked as genera (*Enyalioides*, *Hoplocercus*, and *Morunasaurus*). These lizards are known from elevations below 2000 m on both sides of the Andes between Panama and southeastern Brazil, with most species occurring in Ecuador (10), Colombia (7), and Peru (5).

Several authors have recognized the phylogenetic importance of Hoplocercinae as a possible basal clade within Iguania (Etheridge and de Queiroz 1988; Schulte et al. 1998, 2003). Attempts to infer the phylogeny of Hoplocercinae based on parsimony analyses of morphological characters resulted in several conflicting and weakly supported topologies (Etheridge and de Queiroz 1988; Wiens and Etheridge 2003). However, a recent phylogenetic study based on DNA sequence data yielded a robust phylogenetic tree except for the position of *Morunasaurus*, which was included within *Enyalioides* with low statistical support (Torres-Carvajal and de Queiroz 2009). In addition to these phylogenetic problems, the diversity of Hoplocercinae remains underestimated due to lack of collections from certain areas, or lack of taxonomic work. Wiens and Etheridge (2003) reported two possible new species from Bolivia and Peru, and Torres-Carvajal et al. (2008) recently described a new species of *Enyalioides* from southwestern Ecuador.

All species of *Enyalioides* except for *E. palpebralis* Boulenger 1883 are known from Ecuador (Torres-Carvajal et al. 2008). Of these, three species occur on the western slopes of the Andes and adjacent lowlands (*E. heterolepis* Bocourt 1874, *E. oshaughnessyi* Boulenger 1881, *E. touzeti* Torres-Carvajal et al. 2008) and four occur on the eastern slopes of the Andes and adjacent lowlands (*E. cofanorum* Duellman 1973, *E. laticeps* Guichenot 1855, *E. microlepis* O'Shaughnessy 1881, *E. praestabilis* O'Shaughnessy 1881). Here we describe a new species of *Enyalioides* that was discovered in 2008 on a Smithsonian-funded expedition to the upper basin of Río Zamora on the eastern slopes of the Andes in southern Ecuador. A few additional specimens of the new species were collected in 2009 by scientists from Escuela Politécnica Nacional del Ecuador and Conservation International on the western slopes of Cordillera del Cóndor. This finding highlights the importance of collecting in poorly explored areas of Ecuador and South America.

Materials and methods

Museum acronyms are listed in Leviton et al. (1985) except for the following institutions in Quito, Ecuador: Fundación Herpetológica Gustavo Orcés (FHGO) and Museo de Zoología, Pontificia Universidad Católica del Ecuador (QCAZ). Snout–vent length (SVL) and tail length (TL) measurements were taken with a ruler and recorded to the nearest millimeter. All other measurements were made with digital calipers and recorded to the nearest 0.1 mm. Sex was determined by noting the presence of hemipenes. We

follow the terminology of Vitt and de la Torre (1996) for measurements, and Avila-Pires (1995) and Smith (1946) for squamation. Differences in quantitative characters between the new species and *E. praestabilis* were evaluated with t-tests after log-transforming morphometric data. One of the assumptions of the t-test for two samples is that the variances of both samples are equal; therefore, F-tests also were performed for each character to test for equality of variances. Statistical tests were performed in PAST 1.27 (Hammer et al. 2004). Specimens of *E. praestabilis* examined in this study are listed in the appendix.

Results

***Enyalioides rubrigularis* sp. n.**
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Holotype. QCAZ 8483 (Fig. 1), an adult male from finca de Mesías San Martín (3°51'23"S, 78°51'53"W, 1154m), near Piuntza, Provincia Zamora Chinchipe, Ecuador, collected on 23 June 2008 by O. Torres-Carvajal, E. Arbeláez, A. Carvajal-Campos, and D. Salazar.

Paratypes. ECUADOR: Provincia Zamora Chinchipe: QCAZ 8484, same collection data as the holotype; QCAZ 8454, 8456–58, 8460, 8481–82, near Piuntza (3°51'25"S, 78°51'56"W, 1258m), collected between 20–23 June 2008 by same collectors as for the holotype; QCAZ 8459, 8486, near Piuntza (3°51'26"S, 78°51'40"W, 1192m), collected between 22–24 June 2008 by same collectors as for the holotype; QCAZ 8485, near Piuntza (3°51'26"S, 78°51'43"W, 1170m), collected on 24 June 2008 by same collectors as for the holotype; QCAZ 9089, Alto Miazi, upper Río Nangaritza, Cordillera del Cóndor (4°14'46"S, 78°36'59"W, 1318 m), collected on 12 April 2009 by S. Aldás, J.M. Guayasamin, Holger; EPN 11356, Los Encuentros, Bosque Protector el Zarza (3°50'2"S, 78°31'23"W, 1460 m), collected on 7 November 2008 by A. Almendáriz, M. Salazar, M. Angamarca; EPN 12432–33, Los Encuentros, Concesión Cuy (3°48'28"S, 78°36'21"W, 1450 m), collected on 27 March 2008 by A. Almendáriz, P. Vivanco, C. Sarango.

Diagnosis. The new species differs from all other species of *Enyalioides*, except for *E. praestabilis*, in having distinct caudal whorls, smooth or feebly keeled ventrals, fewer than 32 longitudinal rows of dorsals in a transverse line between dorsolateral crests at midbody, and in lacking projecting dorsal and limb scales. Males of the new species can be distinguished from *E. praestabilis* by having larger scales on the ventral surface of the thighs (Fig. 2), and by having gulars with black margins (Fig. 3). The skin between gulars is black in some male specimens of *E. praestabilis*, but gulars lack black margins. In addition, gular scales in males of the new species vary between bright orange and red, and there is no black mark on the gular region posteromedially; males of *E. praestabilis* have cream or yellow gular scales, and some specimens have a black patch covering the gular fold and posteromedial portion of the gular region (Fig. 3). The new species usually has two femoral pores, whereas *E. praestabilis* has normally one

Figure 1. Holotype of *Enyalioides rubrigularis* sp. n. (QCAZ 8483, adult male, SVL = 123 mm). Top: lateral view; middle: close-up of head; bottom: ventral view. Photographs by O. Torres-Carvajal.

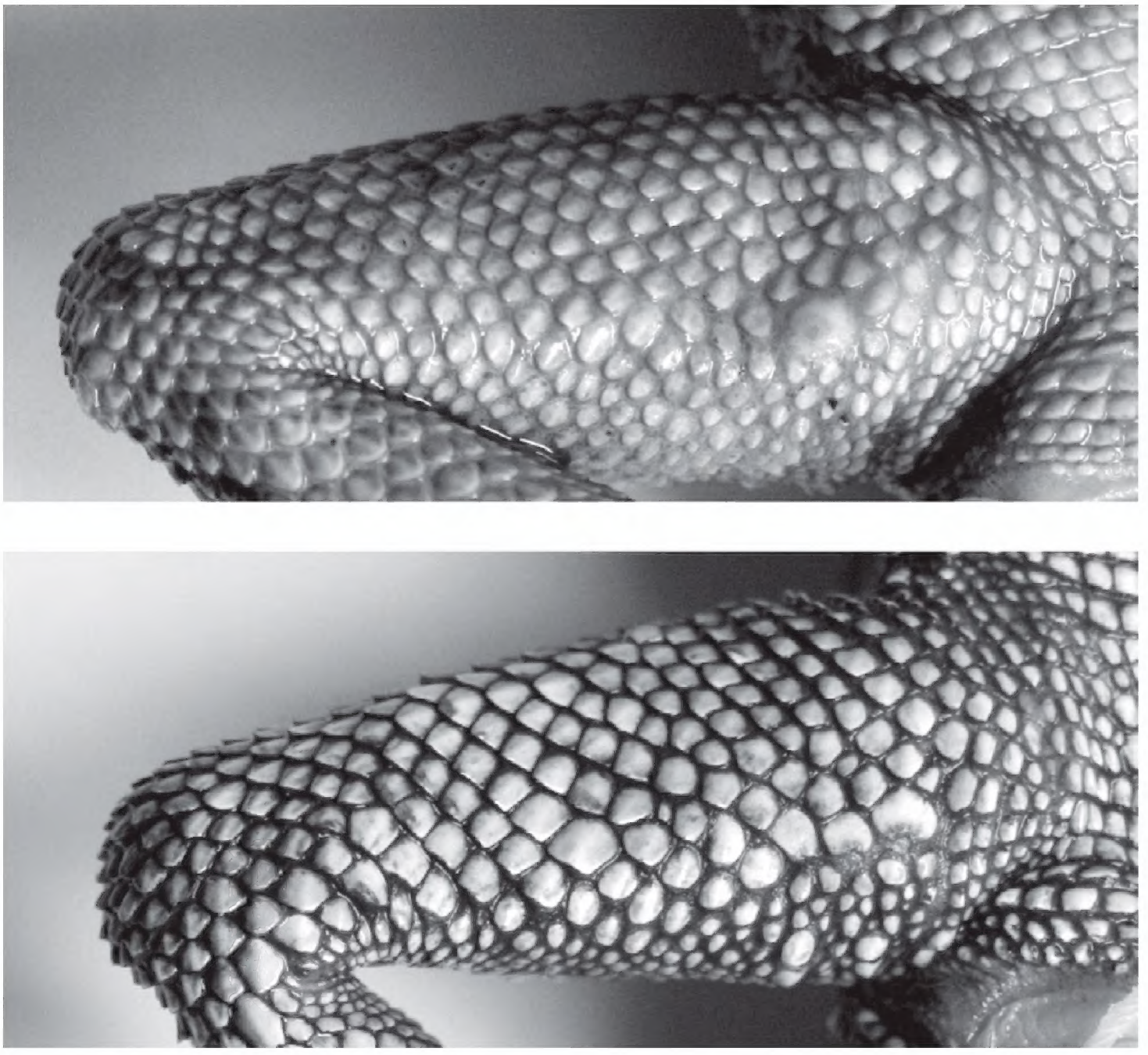

Figure 2. Ventral view of thigh in two species of *Enyalioides*. Top: *E. praestabilis* (QCAZ 8821, adult male, SVL = 110 mm); bottom: *E. rubrigularis* sp. n. (QCAZ 8459, adult male, SVL = 122 mm). Photographs by O. Torres-Carvajal.

femoral pore; otherwise, both species are very similar in scale counts and morphometric characters (Table 1).

Description of holotype. Male (Fig. 1); SVL = 123 mm; TL = 180 mm; maximum head width = 25.96 mm; head length = 32.37 mm; head height = 23.73 mm; dorsal head scales keeled or multicarinate, those on parietal region strongly projected dorsally; scales immediately posterior to supraciliares conical and dorsally projected, forming longitudinal row of seven (left) or six (right) scales that extends posteriorly over supratemporal region; temporal scales small, smooth or keeled, juxtaposed; two large, projected conical temporal scales aligned anterodorsally from anterodorsal aspect of tympanum; one enlarged pretympanic scale; supraciliares 16; canthals five; postrostrals four; left supralabials nine if counted to a point right below middle of eye, and 13 if counted to commisure of mouth (10 and 13 on right side, respectively); rostral (3.67 × 1.64 mm) about twice as wide as adjacent supralabials; single longitudinal row of

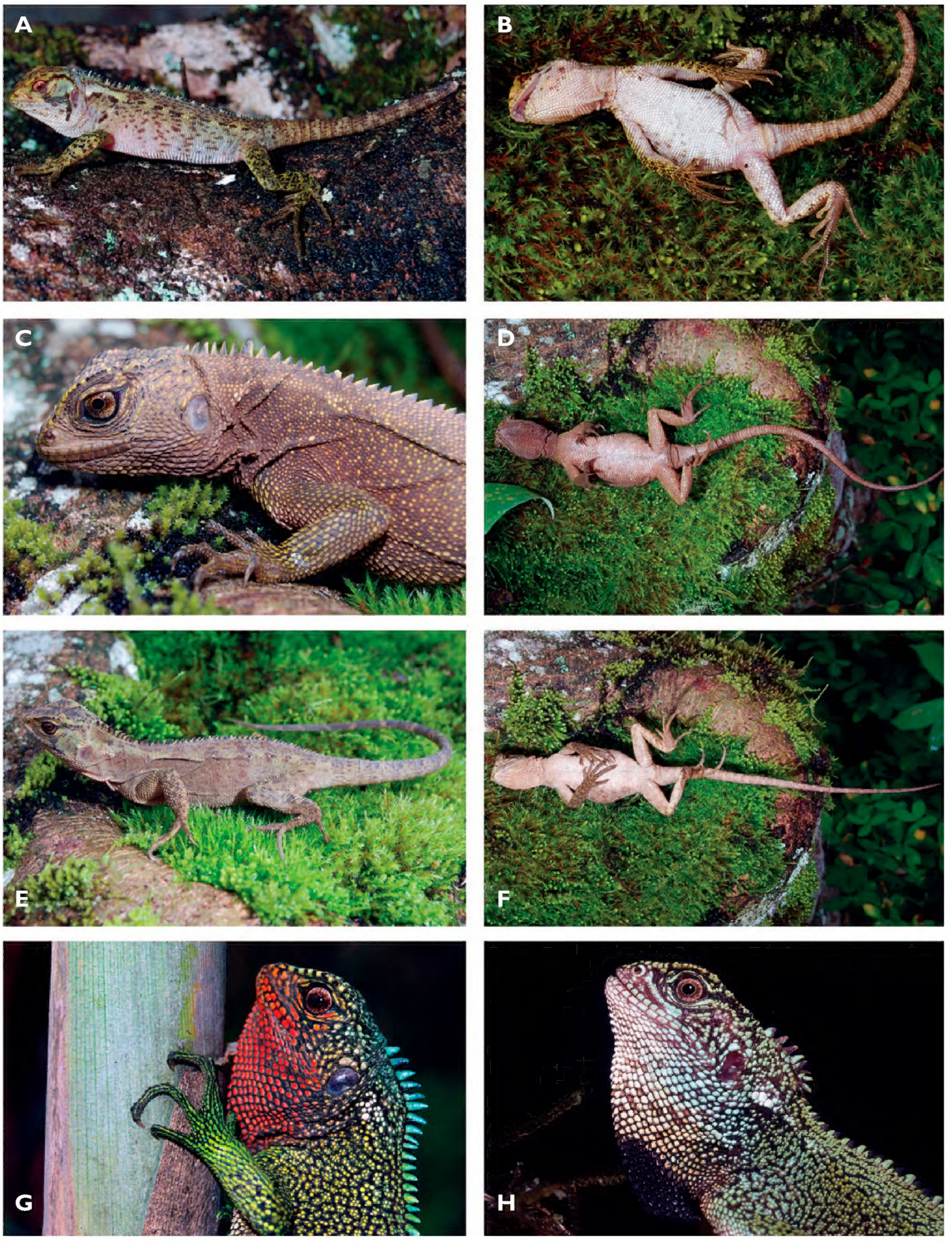

Figure 3. Two species of *Enyalioides*. Juvenile (A, B, QCAZ 8454), females (C, D, QCAZ 8457; E, F, QCAZ 8458), and male (G, QCAZ 8460) of *E. rubrigularis* sp. n.; male of *E. praestabilis* (H, KU 169854). Photographs by O. Torres-Carvajal (A-G) and W. E. Duellman (H).

lorilabials between suboculars and supralabials at level of middle of eye, longitudinal rows of lorilabials anterior to this point 2–3; loreal region broken into small, smooth, and juxtaposed scales; nasal at level of supralabial III; left infralabials eight if counted

Table 1. Summary of morphological characters, measurements (mm), and color patterns of *Enyalioides praestabilis* and *E. rubrigularis* sp. nov. For each quantitative character, the *F*-value, *t*-value, and corresponding *P*-values are given. Range (first line), and mean ± standard deviation or mode (second line) are given for quantitative characters.

Character	*E. praestabilis* N = 50	*E. rubrigularis* N = 16	F-value	P	t-value	P
Dorsals in transverse row between dorsolateral crests at midbody	21–39 28.37 ± 3.91	25–32 28.79 ± 2.61	2.249	0.115	0.369	0.714
Ventrals in transverse row at midbody	21–39 28.69 ± 3.87	22–31 26.07 ± 2.37	2.665	0.059	2.381	0.021
Vertebrals from occiput to base of tail	44–66 54.64 ± 5.43	49–58 52.79 ± 2.64	4.243	0.007	1.224	0.226
Gulars	22–34 27.91 ± 2.99	26–34 29.50 ± 2.65	1.274	0.657	1.776	0.081
Infralabials	7–11 8.86 ± 0.88	7–10 8.86 ± 0.66	1.755	0.271	0.025	0.979
Supralabials	8–12 10.34 ± 1.08	9–11 10.14 ± 0.53	4.060	0.008	0.659	0.512
Canthals	4–6 5	4–6 5	1.097	0.895	1.531	0.133
Superciliaries	12–20 15.56 ± 1.87	13–19 15.64 ± 1.39	1.794	0.263	0.144	0.886
Transverse rows of ventrals between fore and hind limb	31–48 37.77 ± 3.36	31–40 36.57 ± 2.65	1.604	0.359	1.213	0.230
Subdigitals Finger IV	17–24 19.82 ± 1.32	17–22 19.50 ± 1.34	1.036	0.998	0.761	0.450
Subdigitals Toe IV	22–28 25.84 ± 1.54	23–29 25.71 ± 1.94	1.586	0.254	0.252	0.802
Femoral pores	1–2 1	1–2 2	1.262	0.420	2.947	<0.005
Head length/Head width	1.20–1.45 1.32 ± 0.07	1.20–1.39 1.28 ± 0.05	1.146	0.827	1.819	0.074
Fore limb length/SVL	0.47–0.61 0.54 ± 0.03	0.38–0.54 0.49 ± 0.04	2.897	0.010	2.931	0.005
Hind limb length/SVL	0.72–0.95 0.82 ± 0.05	0.72–0.86 0.79 ± 0.05	1.888	0.217	0.951	0.346
Tail length/Total length	0.59–0.66 0.62 ± 0.02	0.59–0.62 0.60 ± 0.01	2.812	0.086	2.806	0.007
Dark gular patch	Present (polymorphic)	absent				

to a point right below middle of eye, and 13 if counted to commisure of mouth (eight and 11 on right side, respectively); mental (4.11 × 2.65 mm) wider and higher than adjacent infralabials; postmentals three; gulars ventrally projected; gular fold complete midventrally; neck with several longitudinal and oblique folds.

Vertebral crest strongly projected and decreasing in size posteriorly, with vertebrals on neck at least four times higher than vertebrals between hind limbs; crest bifurcates

posteriorly and extends onto tail about ¼ its length; body flanks between fore and hind limbs with dorsolateral and ventrolateral folds, as well as several oblique folds; scales on dorsolateral folds slightly larger than adjacent scales giving the fold the appearance of a crest; dorsal scales between dorsolateral folds and vertebral crest small, prominently keeled, and imbricate; scales on flanks (i.e., ventral to dorsolateral folds) similar in size to dorsal scales, with a few scattered enlarged scales 2–3 times larger than adjacent scales; ventral scales imbricate, smooth, rectangular, with a posterolateral mucron; ventrals more than twice the size of dorsals.

Limb scales keeled dorsally and smooth or slightly keeled ventrally; scales on dorsal and posterior aspects of thighs heterogeneous in size, with most scales less than half the size of those scales on anterior and ventral aspects; subdigitals on Finger IV 21; subdigitals on Toe IV 26; two femoral pores on each side; tail laterally compressed and gradually decreasing in height towards tip; caudal scales strongly keeled and imbricate, increasing in size posteriorly on lateral and dorsal aspects of each autotomic segment; ventral larger than dorsal caudals, with individual autotomic segments being three scales long ventrally and six scales long dorsally.

Coloration in life of holotype (Fig. 1). Scales on dorsal and lateral surfaces of head mostly green or yellow, with black margins causing a reticulate pattern; some head scales entirely black; labials and mental yellowish orange with black margins; rostral green medially and black laterally; gulars orange with black margins, a few lateral gulars green or yellow; skin between gulars black; black gular patch absent; six enlarged greenish-cream scales form a distinct spot posterior to tympanum; paraverterbrals and caudals green or dark brown; flanks mottled with lemon-green scales; dorsal limb scales light green, some with dark brown margins; ventral surface of body, limbs, and tail white medially and light green laterally, with irregular light green stripes projecting medially; lining of mouth whitish cream; iris light brown peripherially with dark brown projections originating from the dark brown center.

Color variation. Adult males QCAZ 8456, 8460 differed from the holotype in having a dark brown to black reticulate pattern on dorsal and lateral aspects of body. In addition, male QCAZ 8460 had the dorsal surface of head black with green and yellow dots; loreal and subocular regions with black and red scales; labials red with black margins; gulars red with black margins (Fig. 3). Metachromatism was observed in some individuals, in which the green tones were replaced with yellow or brown tones (Fig. 4).

Adult female QCAZ 8457 (Fig. 3): dorsal background of body, limbs, and tail light brown spotted with yellow scales; dorsal background of head dark brown with scattered black scales; labials yellowish green with grey margins; enlarged pretympanic scale yellow; faint yellowish strip extends longitudinally from tympanum to scapular region; each vertebral yellow anteriorly and grey posteriorly; gular region brown with a few scattered orange scales; ventral surface of body, limbs, and tail brownish cream; iris copper with dark brown reticulations. Adult female QCAZ 8458 (Fig. 3) differed from the latter in having a dark olive green dorsal background, a black stripe extending longitudinally from posterior margin of eye to dorsal margin of tympanum, a black

Figure 4. Metachromatism in *Enyalioides rubrigularis* sp. n. Top left and right: adult male (QCAZ 8460, SVL = 102); bottom left and right: adult male (QCAZ 8456, SVL = 89). Photographs by O. Torres-Carvajal (left) and L. Coloma (right).

stripe extending dorsolaterally from comisure of mouth to eye, and a yellowish cream gular region with scattered black dots.

Juvenile QCAZ 8454 (Fig. 3): dorsal background yellowish green with irregular dark brown marks on head, body, flanks, tail, and black transverse lines on limbs; black stripe extends from posterior margin of eye to dorsal margin of tympanum; another black stripe extends from subocular region to anterior margin of tympanum, from where it extends ventrally into gular region; dorsolateral light green band with brown and black margins extends from temporal to scapular region; vertebrals black and yellowish green; gular region yellowish cream with brown, yellow, and orange scales laterally; ventral surface of body and limbs whitish cream, with faint grey dots; ventral surface of tail similar in color but fainter than dorsal surface; tongue cream with anterior tip grey; lining of mouth whitish cream; iris copper. Juvenile QCAZ 8485 differs from the latter in having a yellowish-brown background, with dark brown transverse bands arranged longitudinally from the scapular region to the tip of the tail.

Natural history. Juvenile QCAZ 8454 was encountered at 5 pm basking in the sun on the ground; when approached it ran quickly into a hole 5 cm wide located 1 m higher in the ground. All other specimens were found sleeping at night (7:00 pm–12:00 am) between 30 cm and 2.5 m above ground. These specimens were found with their heads facing up on vertical stems with diameters varying between 2–10 cm, or lying horizontally on ferns with stems 2–3 cm wide. Most specimens were collected in secondary forest close to pasture.

Distribution. *Enyalioides rubrigularis* inhabits rainforests on the eastern slopes of the Andes and western slopes of Cordillera del Cóndor in southern Ecuador (Fig. 5). It occurs at elevations of 1100–1460 m in the upper basins of the Zamora and Nangaritza rivers, Provincia Zamora Chinchipe. The type locality of *E. rubrigularis* is surrounded by secondary forest, pasture, *Tilapia* ponds, and bullfrog (*Rana catesbeiana*) farms.

Etymology. The name *rubrigularis* is an adjective in the nominative singular and derives from the Latin words *ruber* (=red) and *gula* (=throat). It refers to the characteristic orange or reddish throat and chin of adult males, which distinguishes the new species from other species of *Enyalioides*.

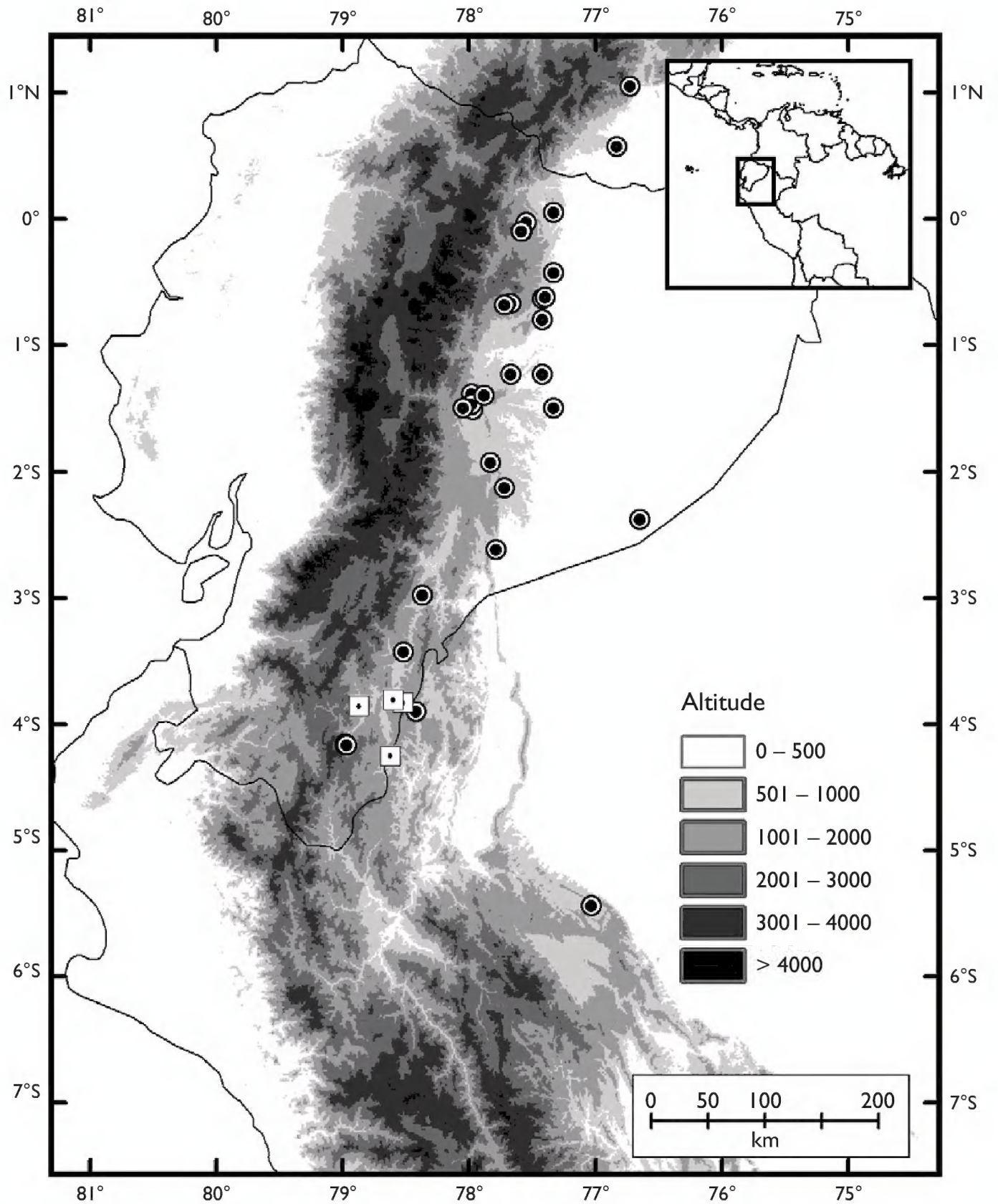

Figure 5. Distribution of *Enyalioides praestabilis* (circles) and *E. rubrigularis* sp. n. (squares).

Key to the species of *Enyalioides* from eastern Ecuador

1. Caudals increase in size posteriorly on each autotomic segment **2**
– Caudals homogeneous in size ..... ***E. laticeps***
2. Ventrals strongly keeled; more than 32 dorsals in a transverse line between dorsolateral crests at midbody **3**
– Ventrals smooth or slightly keeled; usually fewer than 32 dorsals in a transverse line between dorsolateral crests at midbody **4**
3. Dorsals heterogeneous in size, with scattered projecting scales (more conspicuous in adult females); dorsolateral crests well developed between hind limbs ..... ***E. cofanorum***
– Dorsals homogeneous in size, without projecting scales; dorsolateral crests inconspicuous or absent between hind limbs ..... ***E. microlepis***
4. Gulars in males cream or yellow without black margins; usually one femoral pore ..... ***E. praestabilis***
– Gulars in males bright orange or red, with black margins; usually two femoral pores ..... ***E. rubrigularis***

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Appendix

Specimens examined

Enyalioides praestabilis – COLOMBIA: *Putumayo*: KU 169854, 10.3 km W El Pepino; KU 140394, San Antonio, río Guamez; ECUADOR: *Morona Santiago*: QCAZ 6978, km 6 on road Limón-Macas; USNM 211153–54, Chiguaza; QCAZ 9212; Macas, Macuma, Wisui; USNM 211152, 211155, Miazal; KU 147183, Mision Bomboiza; *Napo*: CAS-SUR 8260, Avila, río Napo; USNM 211156–57, Concepción; MCZ 164901, Lumbaquí; QCAZ 5272–74, Parque Nacional Napo Galeras; EPN 7844, 8043–44, Parroquia Catundo, Huamaní; QCAZ 5580–81, 5611, río Hollín; USNM 211158, río Suno; KU 122116–17, S slope Cordillera del Dué above río Coca; QCAZ 136, 7428, San Rafael; *Orellana*: AMNH 28869, 28874–76, 28894, San José de Sumaco [San José Nuevo]; *Pastaza*: USNM 211161, 5 km SSE Puyo; USNM 211165, Arajuno; QCAZ 3797, Centro Fátima, 9 km N Puyo; USNM 211166, Chichirota; AMNH 37555, Palmira, río Pastaza valley; USNM 211161, Puyo; EPN 6497, Puyo, Santana; USNM 211159–60, río Arajuno; USNM 211163–64, río Villano; QCAZ 4113, Shell-Mera; USNM 211167, upper basin río Curaray; *Zamora Chinchipe*: FHGO 2783, Curintza; FHGO 1757, 2117, La Pituca, río Curintza basin; FHGO 2156, La Pituca, upper basin río Curintza; FHGO 5579–81, Pindo-Mirador research station; PERU: *Amazonas*: USNM 525549, Cordillera del Cóndor, upper río Comainas, Alfonso Ugarte (=puesto de vigilancia 3); *Loreto*: AMNH 56402, northern Peru, front range btw. Moyobamba & Cahuapanas.